CLIMATE OF THE MURRAY VALLEY REGION BETWEEN MILDURA AND RENMARK, AUSTRALIA

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General Climatic Influences

The climate of the region may be classified in general terms as continental. This is a direct result of its geographical position on the Australian continent, about 250 km from the nearest point of the coastline, which places it far from the modifying influence and moisture of the Southern Ocean, the fairly constant temperature of which tends to temper the daily variations in air temperature of areas closer to the coast.

In the interior, the land surface is heated strongly by solar radiation by day and chills rapidly by night as it radiates heat, often assisted by clear skies and a dry atmosphere.

The latitude of the site and indeed of the whole continent plays a considerable role in the composition of the resulting climate. At latitude 34°S, at the Dam Site, a strong seasonal variation in temperatures is brought about by the relative positions of earth and sun from winter to summer with long days and intense radiation from the sun almost overhead at midday in mid-summer and the shorter days with lower sun angle and less intense radiation in winter.

The position of the continent in the middle latitudes, lying under the quasi-permanent belt of anticyclones (which is such a feature of the southern hemisphere mid-latitudes) is also important. The antieyclonic belt moves N. and S. with the sun, with easterly winds at low levels (the SE. trades) on its N. side, and westerlies on its S. side. In the mid-summer the Dam Site is frequently on the N. side of the belt and in mid-winter is normally on the S. side, but there are many interruptions to this situation, and this is illustrated by the observed distribution of winds (Table 1). The antieyclonie belt is an integral part of the hemispheric circulation of the atmosphere, and strongly affects the climate of the continent, particularly away from the coast, beeause of the downward circulation of dry air from high levels above it. This tends to maintain clear skies and low rainfall, which are progessively stronger features of the climate as the dry centre is approached.

The region, lying as it does on the fringe of the dry centre has a lower rainfall, higher temperatures and more sunshine and evaporation than any other district in the State of Vietoria.

The topography of the district is generally of low relief, most of the area being less than 100 m in elevation and thus has little effect on rainbearing streams. Rainfall at the site comes mainly from lifting and cooling of moist air by the dynamic proeesses of special weather situations, including thunder-storms, and is therefore variable and somewhat unreliable. Sueh it is also in many other areas of Australia.

Wind streams are of fundamental importance in the make-up of the climate. With the occurrence of low pressure breaks in the antieyclonic belt, winds oeeur which may bring air from any direction. Most outstanding are air streams from the N. or NW. which, in summer, bring extremely hot, dry, dusty air from the interior of the continent and result in heat waves with air temperatures well in excess of 40°C (Table 4). These are relieved by cooler winds from the SW., S. or SE. Persistent winds from the NE., particularly in summer, are warm to hot and moist bringing unpleasant, humid, thundery weather. The effeet of wind direction in winter is much less important.

Climatic Details

Rainfall

The following comments are based mainly on rainfall statisties for Ned's Corner, but some

TABLE 1

FREQUENCY ANALYSIS OF WIND DIRECTION AGAINST SPEED, MILDURA 1964-68

SPEED RANGES (knots) JANUARY 0900 HOURS

DIR.	CALM	01–03	04–06	07–10	11–16	17–21	22–27	TOTAL
CALM	2	0	0	0	0	0	0	2
NNE.	0	0	2	4	3	1	0	10
NE.	0	3	6	5	1	0	0	15
ENE.	0	1	0	2	0	0	0	3
E.	0	1	3	2	1	0	0	7
ESE.	0	1	3	5	1	0	0	10
SE.	0	0	6	13	1	0	0	20
SSE.	0	0	4	11	5	0	0	20
S.	0	1	3	12	13	0	1	30
SSW.	0	0	1	0	4	1	0	6
SW.	0	1	0	4	5	1	0	11
WSW.	0	0	1	1	0	0	0	2
W.	0	1	0	1	1	0	0	3
WNW.	0	0	0	1	0	0	0	1
NW.	0	1	0	2	0	0	0	3
NNW.	0	0	2	1	2	0	0	5
N.	0	0	1	1	4	1	0	7
SUMS	2	10	32	65	41	4	1	155

SPEED RANGES (knots) JANUARY 1500 HOURS

DIR.	CALM	01–03	04–06	07–10	11–16	17–21	22–27	TOTAL
CALM	1	0	0	0	0	0	0	1
NNE.	0	0	5	1	1	0	0	7
NE.	0	0	1	3	0	0	0	4
ENE.	0	0	0	1	1	0	0	2
E.	0	2	3	0	1	0	0	6
ESE.	0	0	1	2	0	0	0	3
SE.	0	0	2	6	4	0	0	12
SSE.	0	0	2	4	2	0	0	8
S.	0	0	3	7	11	1	1	23
SSW.	0	0	2	2	10	2	0	16
SW.	0	0	2	6	13	2	0	23
WSW.	0	0	1	3	4	2	0	10
W.	0	1	2	5	6	2	1	17
WNW.	0	0	0	0	2	2	1	5
NW.	0	0	0	3	2	0	0	5
NNW.	0	0	0	2	3	0	0	5
N.	0	1	2	2	3	0	0	8
SUMS	1	4	26	47	63	11	3	155

FREQUENCY ANALYSIS OF WIND DIRECTION AGAINST SPEED, MILDURA 1964-68

SPEED RANGES (knots) JULY 0900 HOURS

DIR.	CALM	01–03	04–06	07–10	11–16	17–21	TOTAL
CALM	18	0	0	0	0	0	18
NNE.	0	0	4	4	0	0	8
NE.	0	6	7	3	1	0	17
ENE.	0	0	2	0	0	0	2
E.	0	3	1	0	1	0	5
ESE.	0	0	1	0	0	0	1
SE.	0	0	0	0	0	0	0
SSE.	0	1	2	1	0	0	4
S.	0	2	3	0	0	0	5
SSW.	0	2	1	4	0	0	7
SW.	0	1	4	4	1	1	11
WSW.	0	0	4	2	1	0	7
W.	0	0	6	4	4	0	14
WNW.	0	2	1	7	2	0	12
NW.	0	2	5	6	5	0	18
NNW.	0	0	1	3	1	1	6
N.	0	5	3	8	2	2	20
SUMS	18	24	45	46	18	4	155

SPEED RANGES (knots) JULY 1500 HOURS

DIR.	CALM	01–03	04–06	07–10	11–16	17–21	22–27	28–33	34–40	TOTAL
CALM	2	0	0	0	0	0	0	0	0	2
NNE.	0	0	1	4	0	0	0	0	0	5
NE.	0	0	2	2	1	0	0	0	0	5
ENE.	0	0	0	0	0	0	0	0	0	0
E.	0	1	0	0	0	0	0	0	0	1
ESE.	0	1	0	0	0	0	0	0	0	1
SE.	0	0	1	2	0	0	0	0	0	3
SSE.	0	1	2	0	0	0	0	0	0	3
S.	0	2	1	4	4	1	0	0	0	12
SSW.	0	1	2	1	6	0	0	0	0	10
SW.	0	0	1	2	7	1	0	0	0	11
WSW.	0	0	2	6	2	3	1	0	0	14
W.	0	1	4	6	6	1	2	0	1	21
WNW.	0	0	5	2	2	0	1	0	0	10
NW.	0	1	3	6	11	2	1	0	0	24
NNW.	0	0	1	5	5	1	0	0	0	12
N.	0	2	5	3	8	2	1	0	0	21
SUMS	2	10	30	43	52	11	6	0	1	155

TABLE 2

RAINFALL STATISTICS

Ned's Corner— Lat. 34°12′ S. Long. 141°30′ E.

Mildura Aerodrome—Lat. 34° 14′ S. Long. 142°05′ E. Elevation 165 ft. (50 m)

	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	An-nual
AVERAGE RAINFALL (100 points = 1 inch)														
Ned's Corner	1927–1972	63	82	67	75	83	83	95	85	75	96	96	72	972
Mildura	1946–1972	70	86	94	72	113	88	98	105	104	108	102	80	1120
AVERAGE NUMBER OF RAIN DAYS (One point or more)														
Ned's Corner		2	2	2	3	4	4	5	5	3	4	3	2	39
Mildura		3	3	4	5	6	7	9	8	6	7	6	3	67
HIGHEST 24-HOUR RAINFALL (Points)														
Ned's Corner		158	406	252	88	130	122	105	107	155	189	303	217	
Mildura		198	327	257	153	133	175	94	116	142	180	155	185	
Ned's Corner	MONTHLY AND ANNUAL RAINFALL DECILES (Points)													
Lowest		0	0	0	0	0	0	0	11	0	0	0	0	
Decile 1		0	0	0	0	7	9	35	23	17	21	0	2	
„ 2		1	0	0	11	19	19	56	41	21	29	12	14	
„ 3		12	5	3	22	36	26	62	52	27	35	32	20	
„ 4		16	20	14	37	45	33	71	60	44	49	42	35	
„ 5		26	39	31	44	65	53	83	80	58	62	61	52	
„ 6		62	52	45	50	81	100	104	100	77	104	77	70	
„ 7		93	83	66	113	104	120	113	117	99	136	120	91	
„ 8		127	143	87	133	135	153	129	143	126	165	166	133	
„ 9		196	221	174	191	198	235	180	172	168	236	274	162	
Highest		362	574	551	323	251	387	222	190	344	279	435	361	

rainfall data for Mildura have also been used.

In considering rainfall it is important to look further than the simple averages which are given in Table 2. These show that more rain and rain days are experienced from about April to November than in the remaining months.

The monthly and annual figures for rainfall at Ned's Corner for individual months and years (Table 3) from 1927 to 1972 illustrate this point very clearly. The January average of 63 points calculated over 43 years provides a good example. Only in five years (1935, 1944, 1958, 1959 and 1970) does the January rainfall come within 10 points of the average. There are nine years when the January rainfall was zero and 12 years when it exceeded 100 points. There is a similar pattern in the other months, and these considerations lead to the decile approach to rainfall reliability as illustrated by the figures in Table 2.

The deciles 1-9 are derived by arranging the rainfalls in order of magnitude and determining by interpolation the values of rainfall, the nine decile values, which divide the distribution into 10 parts, each of equal frequency. For example, from Table 2 we have that the lowest 10 per cent of January rainfalls do not exceed zero, 20 per cent do not exceed one point and so on. The median or 50 percentile is 26 points whilst decile nine, in this case 196 points indicates that 90 per cent of the values may be expected in the long run, based on the figures available not to exceed 196 points.

Some idea of the incidence of heavy rainfall

MONTHLY AND ANNUAL RAINFALL TOTALS, NED'S CORNER, VICTORIA (34°12'S. 141°30'E.)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1927	27	4	36	0	30	27	127	63	61	64	65	17	521
1928	0	359	77	45	34	189	109	11	58	75	0	65	1022
1929	10	139	18	11	6	19	29	25	75	0	45	361	738
1930	0	19	65	38	60	10	109	181	52	187	67	186	974
1931	17	0	93	183	136	271	56	50	165	62	136	26	1195
1932	14	128	142	121	129	135	83	190	43	25	42	60	1112
1933	97	12	0	44	103	24	77	122	138	54	333	163	1167
1934	42	39	45	102	0	23	61	55	69	265	182	15	898
1935	62	0	85	128	18	38	61	59	99	137	0	70	757
1936	362	83	87	47	153	73	187	40	17	72	12	99	1232
1937	201	0	35	44	65	126	68	182	22	146	25	133	1047
1938	112	55	0	50	22	12	214	50	0	34	0	0	549
1939	0	421	14	22	77	86	104	129	47	24	269	0	1193
1940	14	0	0	161	21	10	56	40	54	41	57	35	489
1941	306	5	71	13	10	242	145	106	41	250	95	20	1304
1942	13	66	0	178	177	147	85	147	25	279	28	12	1157
1943	22	30	0	23	8	10	13	66	94	35	22	50	373
1944	61	10	0	12	85	0	57	19	7	61	70	61	443
1945	0	24	8	0	36	187	112	91	33	124	94	96	805
1946	130	144	121	49	45	102	129	47	13	24	227	105	1136
1947	12	155	314	24	0	100	119	77	114	131	120	79	1245
1948	0	8	0	126	42	99	83	47	21	174	56	41	697
1949	26	47	31	5	234	27	39	18	108	152	70	14	771
1950	0	574	551	24	126	30	96	104	27	30	120	50	1732
1951	-	-	-	75	77	387	62	150	78	-	-	-	-
1952	137	45	27	39	251	47	25	55	45	232	200	11	1114
1953	162	27	0	0	0	113	79	175	299	-	51	25	-
1954	27	0	0	220	40	26	85	170	21	163	166	158	1076
1955	15	149	8	39	199	231	63	116	153	35	85	0	1093
1956	5	0	222	144	210	154	222	90	130	159	38	0	1374
1957	0	97	27	37	45	165	109	40	20	50	0	187	777
1958	63	39	4	37	110	5	137	161	93	238	311	.15	1213
1959	73	83	54	0	48	4	49	11	81	190	0	49	642
1960	192	79	15	116	198	53	175	88	129	30	130	4	1209
1961	5	65	65	134	12	20	122	60	110	32	435	78	1138
1962	207	4	44	0	129	27	64	97	19	43	4	161	799
1963	113	3	41	112	83	280	121	.125	21	131	40	85	1155
1964	92	0	0	203	73	48	47	125	344	125	41	142	1240
1965	0	0	0	21	71	118	201	152	173	56	131	85	1008
1966	23	198	87	17	44	103	70	53	21	91	77	136	920
1967	23	157	0	0	59	8	54	80	17	24	0	3	425
1968	108	1	56	86	93	151	104	109	61	48	33	109	959
1969	7	256	357	3	186	19	155	40	100	7	10	22	1162
1970	70	0	10	249	18	53	0	102	255	19	279	20	1075
1971	0	21	91	323	87	89	72	60	30	0	31	53	857
1972	182	45	0	-	-	-	-	-	-	-	-	-	-
SUMS 43	2688	3519	2901	3230	3573	3588	4094	3653	3206	4119	4146	3076	41793
MEANS	63	82	67	75	83	83	95	85	75	96	96	72	972

N.B. 100 points = 1 inch

may be obtained from figures showing the greatest 24 hour rainfalls measured. For Ned's Corner and Mildura these are given in Table 2 and show that from two to four inches of rain have occurred in 24 hours from October to March and from one to two inches in the remaining months.

Temperature

Temperatures at Mildura are generally representative of the site area and for this reason statistics for Mildura are included in Table 4.

It is noteworthy that as well as the obvious seasonal variations there are considerable variations in temperature from year to year. The average daily maximum temperature for January, for example, in 1939 was 38·2°C and in 1906, 39·1°C but in 1899 was 29·1°C and in 1924, 29·3°C. This illustrates the differences which can occur between a very hot and dry January and a cooler, cloudy January in which temperatures are consistently lower than normal. In winter, the range in similar circumstances was about 5°C.

Overnight minimum temperatures also show considerable variation from year to year. The mean minimum temperature in January 1904 was 11·9°C and in January 1939 it was 21·3°C. In winter the same effect occurs but the range is again about 5°C between typical cold and warm winters.

Humidity

The climate is normally dry, particularly in summer afternoons when the relative humidity at 3 p.m. averages about 25 to 30 per cent (Table 4). In winter the air is cooler, and relative humidities are higher, although the water content of the air is not great. There are, of course, periods throughout the year when moist streams reach the area. In the warmer months, as mentioned earlier, the heat and humidity

TABLE 4

Mildura—Lat. 34°14′ S. Long. 142°05′ E. Elevation 165 ft. (50 m)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
AVERAGE MAXIMUM TEMPERATURE °C											
32·9	32·6	29·3	24·1	19·7	16·1	15·4	17·8	21·2	25·0	29·0	31·6
EXTREME MAXIMUM TEMPERATURE °C											
50·8	47·8	46·4	37·2	32·2	26·7	25·6	30·5	35·6	40·0	45·0	49·7
AVERAGE MINIMUM TEMPERATURE °C											
16·5	16·4	13·7	9·9	7·4	5·3	4·6	5·7	7·7	10·2	13·1	15·1
EXTREME MINIMUM TEMPERATURE °C											
4·4	6·1	2·8	1·1	—2·8	—3·3	—4·4	—1·7	—1·7	1·1	1·7	4·4
9 a.m. TEMPERATURE (DRY BULB) °C											
23·2	22·7	19·9	15·4	11·6	8·2	7·6	10·1	13·6	17·4	20·5	22·7
9 a.m. TEMPERATURE (WET BULB) °C											
16·8	17·2	15·4	12·2	9·6	9·9	6·4	7·9	10·3	12·8	14·7	16·3
9 a.m. RELATIVE HUMIDITY—PER CENT											
50	55	60	67	75	82	83	73	63	57	50	48
3 p.m. TEMPERATURE (DRY BULB) °C											
31·1	30·4	27·4	22·7	18·7	15·6	14·9	17·0	20·2	23·0	26·3	29·3
3 p.m. TEMPERATURE (WET BULB) °C											
18·9	19·8	17·9	15·1	13·1	11·2	10·3	11·1	12·7	14·7	16·5	17·8
3 p.m. RELATIVE HUMIDITY—PER CENT											
26	32	35	39	51	55	52	43	36	35	31	27

associated with occasional moist streams from the NE. or E. make conditions most uncomfortable.

Wind

This element is important because under certain conditions, considerable wind erosion may occur. Table 1 gives the frequencies of occurrence of wind from each of 16 points of the compass in relation to various wind speed ranges over a period of five years with one observation per day or 155 in all for five Januarics or five Julys.

Gales are comparatively rare, and tend to blow mainly from the NW, W. and SW, with an occasional northerly gale in summer. In winter and spring in particular, sudden wind changes may bring fairly short periods of gale from the W. or SW. Over a period of 25 ycars at Mildura Aerodrome there were 19 days of gale (mean wind over 38 knots) and 653 strong wind days (mean wind ovcr 22 knots at some time during thc day).

Table 5 shows the distribution of these occurrences in the various months of the ycar. The gales and strong winds are clearly most prevalent in January, August, September, October and November.

Duststorms

The area is subject to duststorms which occur chiefly in dry years and in summer months because of their physical nature, which requires strong surface heating with its associated unstable turbulcnt air in the lower layers of the atmosphere. Table 6 shows the numbers of duststorms which have occurred at Mildura from 1946-71 inclusive.

Thunderstorms

Thcse are mainly a summer phenomenon but may occur at any period of the year (Table 6).

Frost

The average number of frosts each month is given in Table 6. There is considerable variation in the frost season from year to year. The average dates of the first and last frosts are 31st May and 1st September, but frost has occurred as early at 19th April and as late as 1st October.

Evaporation

Evaporation rates are high at the Dam Site because of the temperature, wind and humidity conditions. See Table 6 for monthly averages for Mildura based on observations with a Class A Pan from 1967-1972. Lake evaporation is approximately 70 per cent of the Class A Pan figures, or about 55 inches per annum.

Sunshine

The average sunshine hours at Mildura range from 5·8 hours per day in June to 11·3 hours per day in January (Table 6). These figures agree well with the story of the climate as presented above, and are indicative of the large percentage of warm, almost cloud-free days cxperienced.

TABLE 5

GALES AND STRONG WINDS, MILDURA

Lat. 34°14′ S. Long. 142°05′ E. Elevation 165 ft. (50 m)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
FREQUENCY OF OCCURRENCE OF GALES (Mean wind > 38 knots) AND STRONG WINDS (Mean wind > 22 knots) 1946–1971													
GALES	1	0	1	0	0	0	1	3	8	2	2	2	20
STRONG WINDS	75	27	38	25	31	28	49	75	116	97	82	55	698

(The above are the total numbers observed in 27 years)

TABLE 6

MILDURA—Lat. 34°14′S. Long. 142°05′ E. Elevation 165 ft. (50 m)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Septt.	Oct.	Nov.	Dec.	Annual
FREQUENCY OF OCCURRENCE OF DUSTSTORMS TOTAL OCCURRENCES 1946–1971												
27	22	27	9	5	4	4	9	14	17	20	25	183
(Greatest annual total 1960 (29), least 1949, 1957, 1958, 1979 (Nil))												
FREQUENCY OF OCCURRENCE OF THUNDERSTORMS TOTAL OCCURRENCES 1947–1971												
35	30	23	13	4	2	4	5	13	20	35	28	212
(Greatest annual total 1971 (18), least 1948, 1949, 1958 (Nil))												
AVERAGE EVAPORATION AT MILDURA (Inches) (1967–1972)												
12·29	11·09	8·70	5·37	2·95	1·94	2·02	2·81	4·96	8·14	8·05	12·00	80·32
AVERAGE DAILY SUNSHINE (Hours)												
11·3	10·6	8·9	8·3	7·1	5·8	6·4	7·3	8·3	8·9	10·0	10·8	
FREQUENCY OF OCCURRENCE OF FROSTS TOTAL OCCURRENCES 1947–1971												
29	28	24	24	40	175	203	122	40	6	4	0	695
FREQUENCY OF OCCURRENCE OF HAIL TOTAL OCCURRENCES 1947–1971												
0	0	2	0	1	0	1	3	0	1	3	1	12
FREQUENCY OF OCCURRENCE OF FOG TOTAL OCCURRENCES 1947–1971												
0	1	2	7	54	92	72	44	13	11	1	2	299